

HOT METAL SWITCH



2016 iGEM Jamboree
Hynes Convention Center, Boston, MA
October 29, 2016





HOT METAL SWITCH



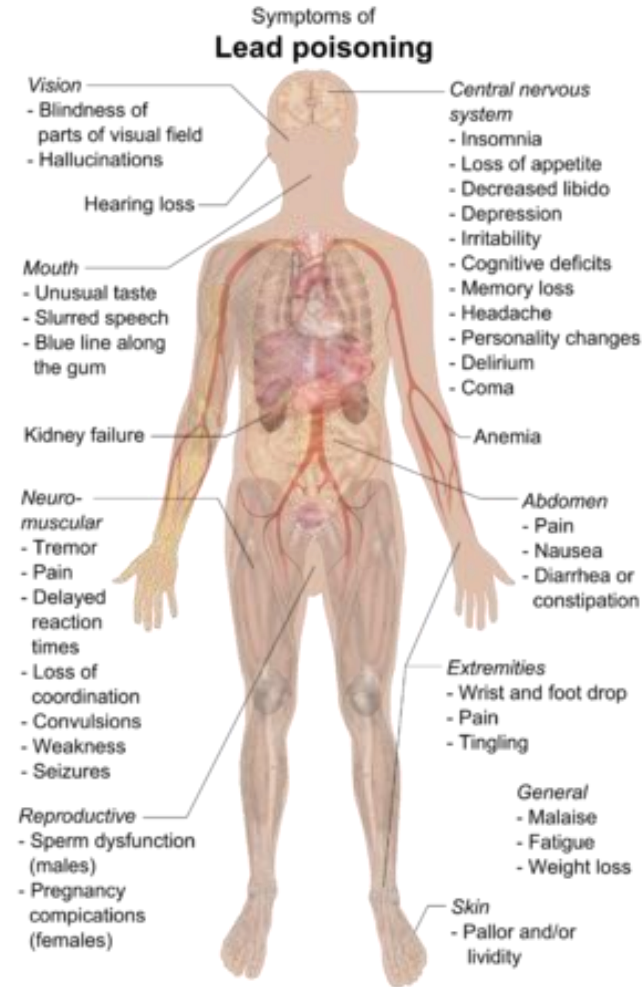




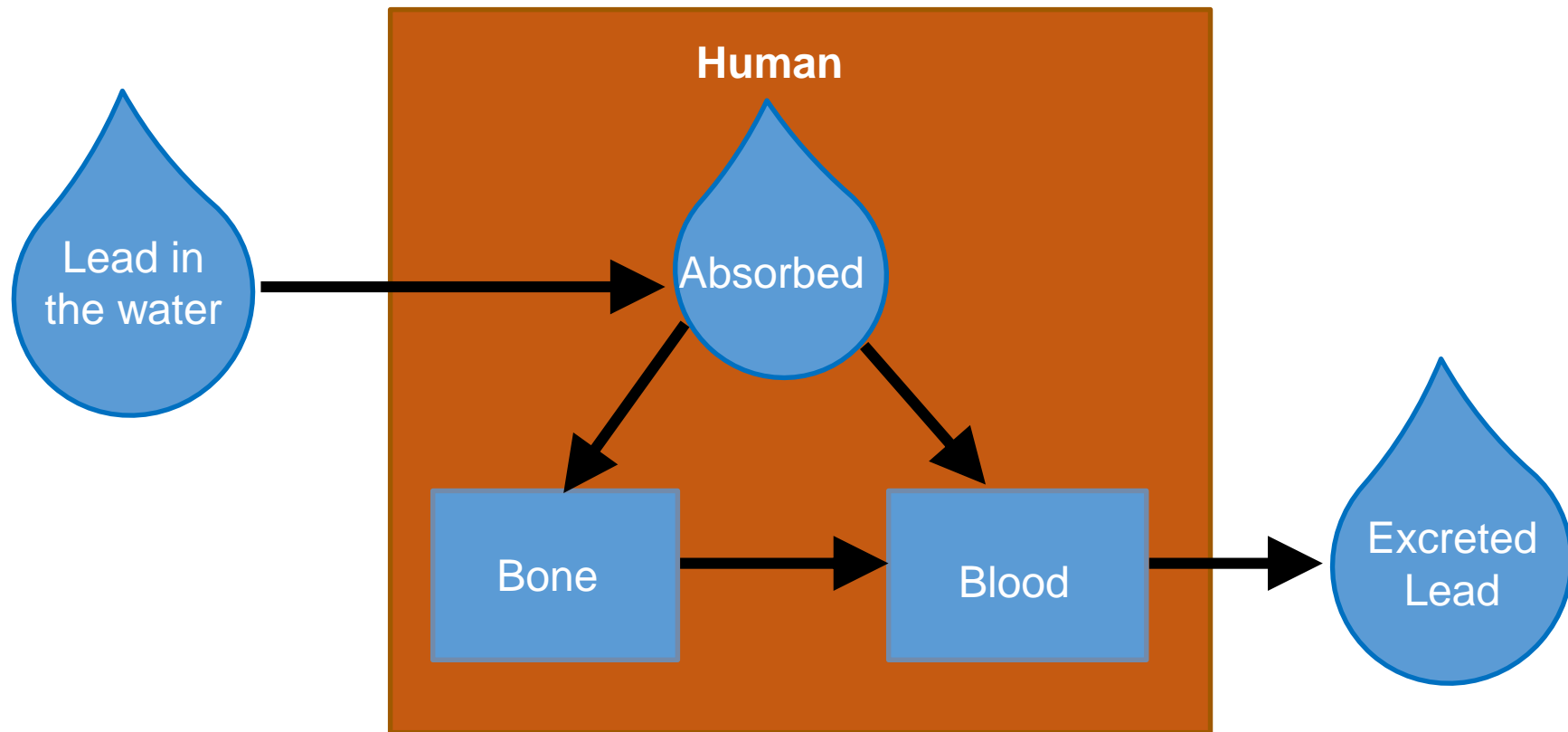
Global Issue



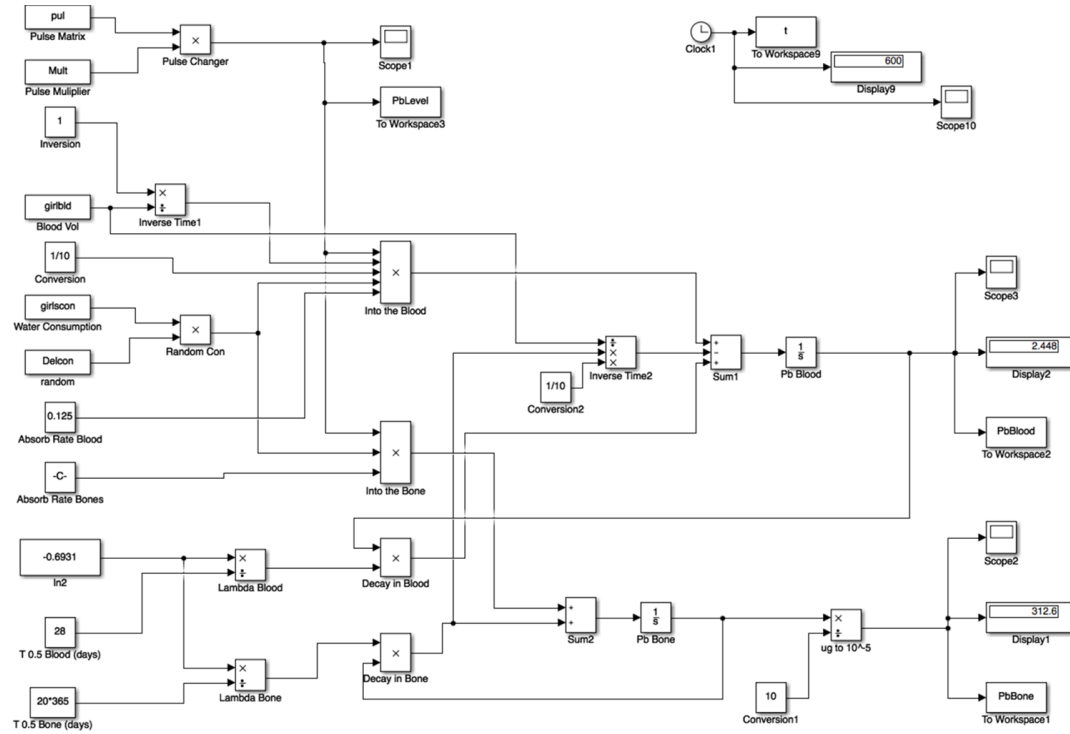
- WHO Lead Poisoning Prevention Week
 - October 23-29th
 - Toxic
 - Children: Behavioral, Neurological
 - Adults: Liver and kidney damage



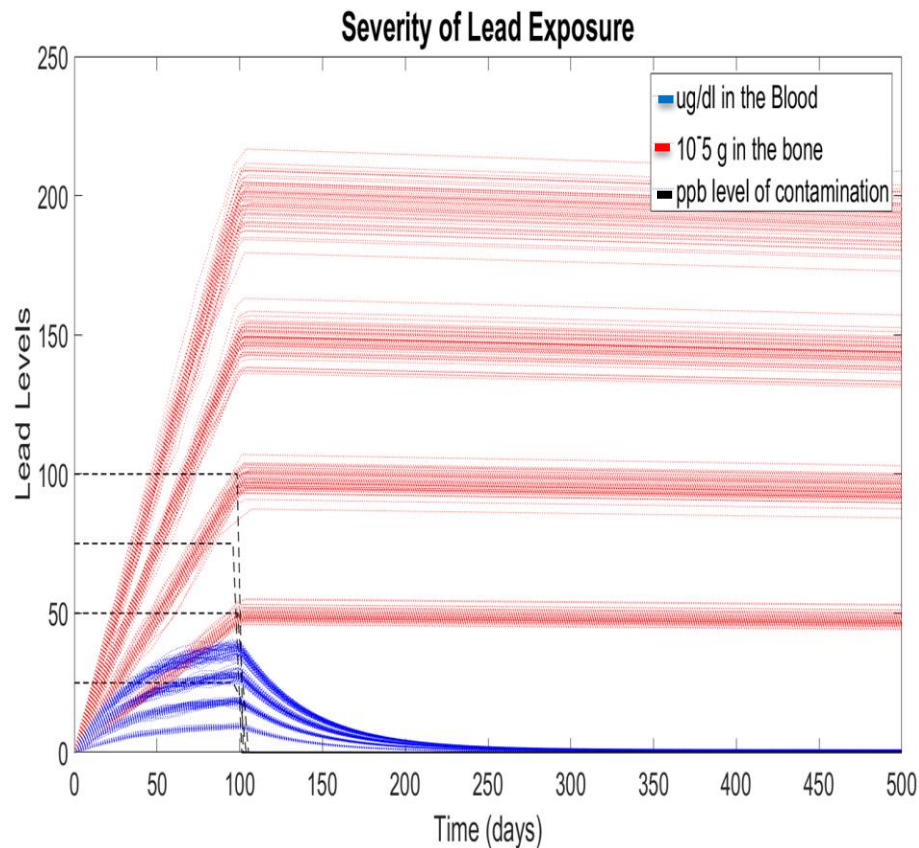
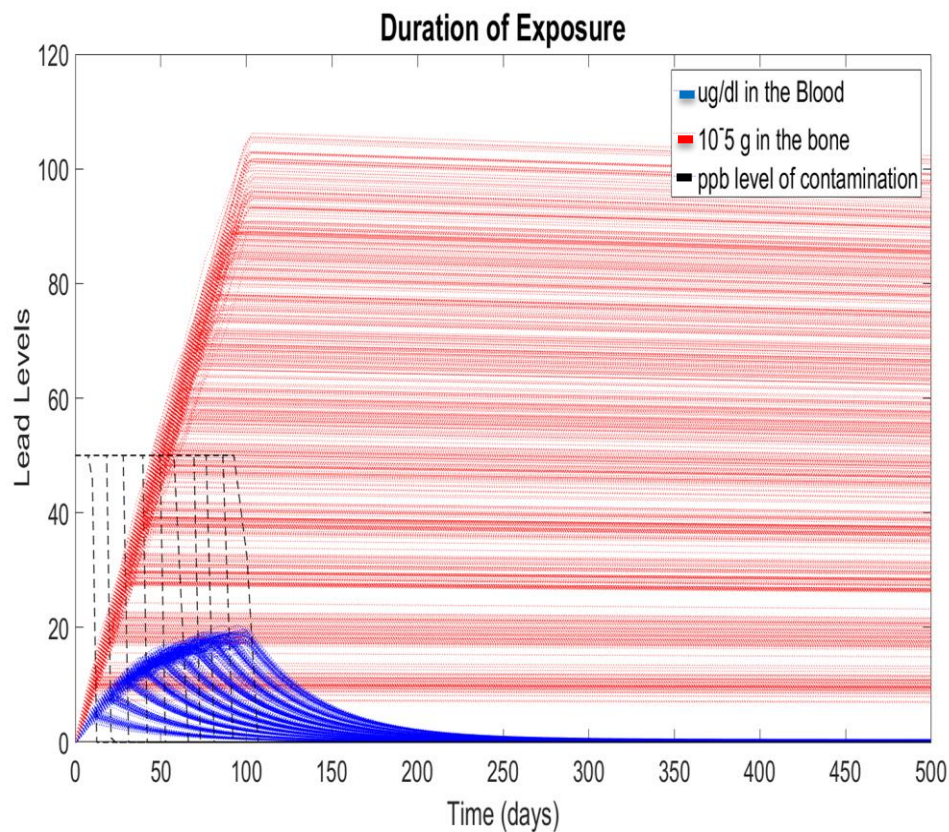
Model



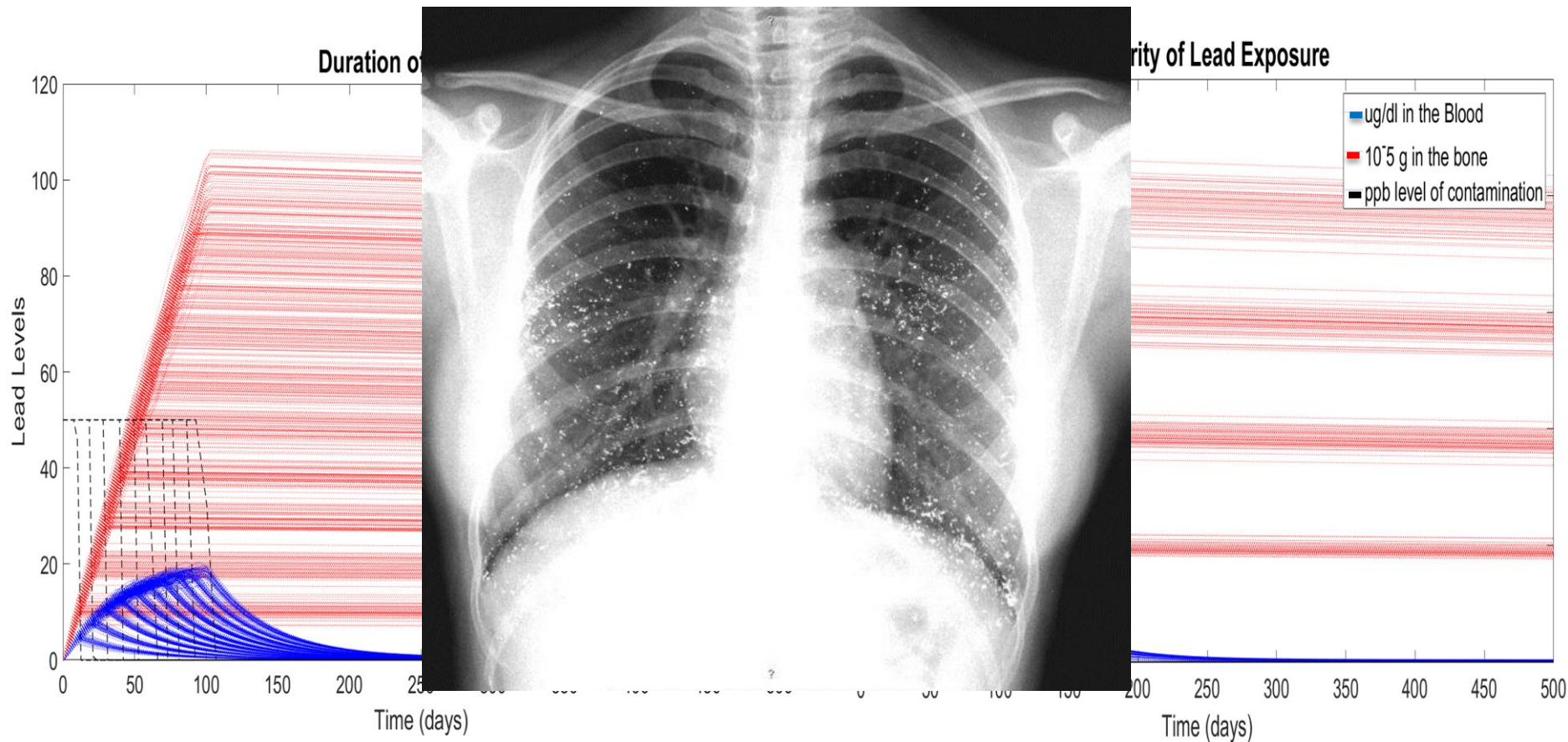
Simulink



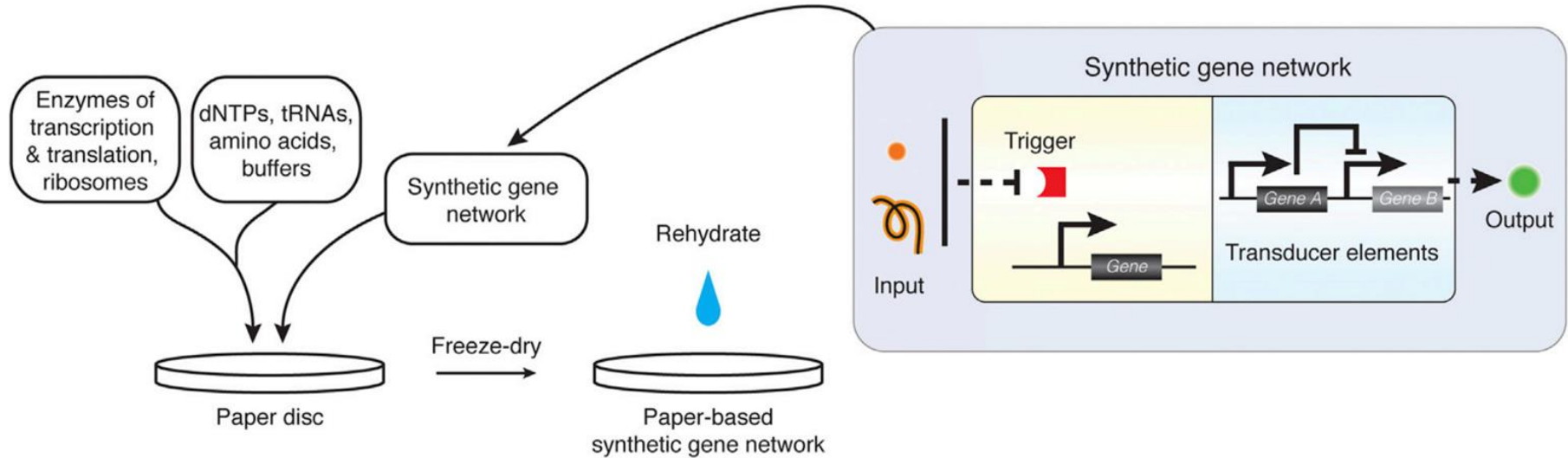
Model Results: Retention of Lead in Bone and Blood



Model Results: Retention of Lead in Bone and Blood

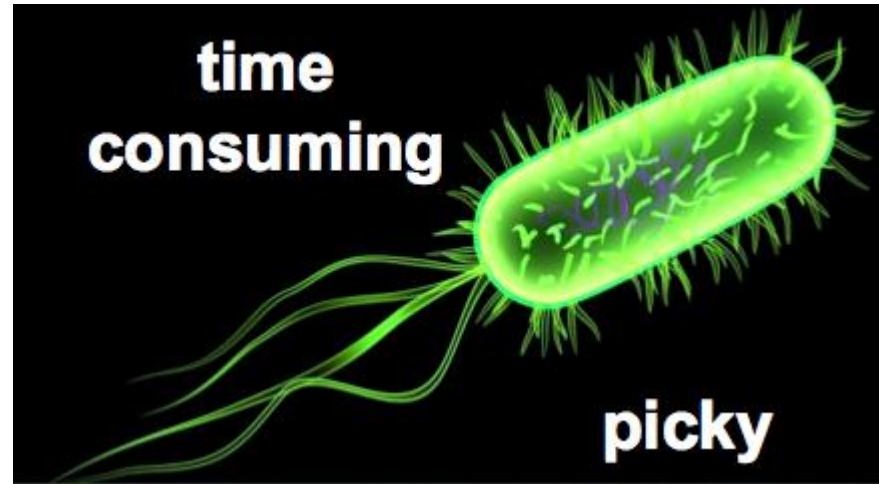
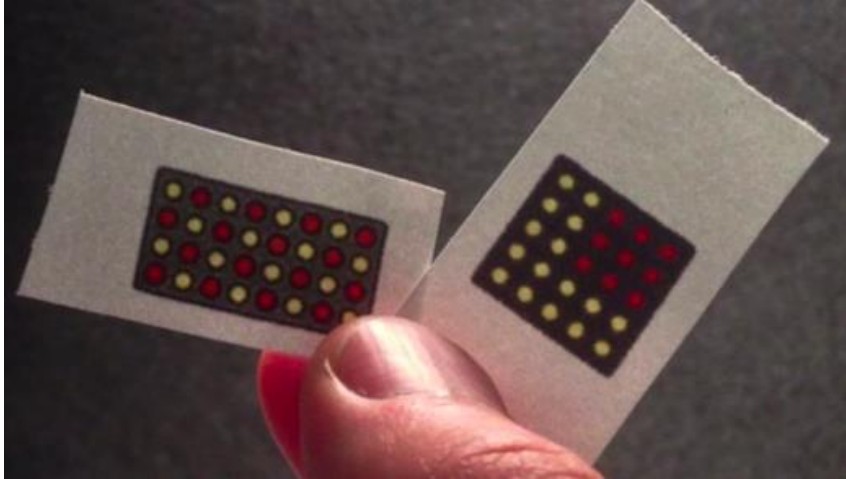


Background

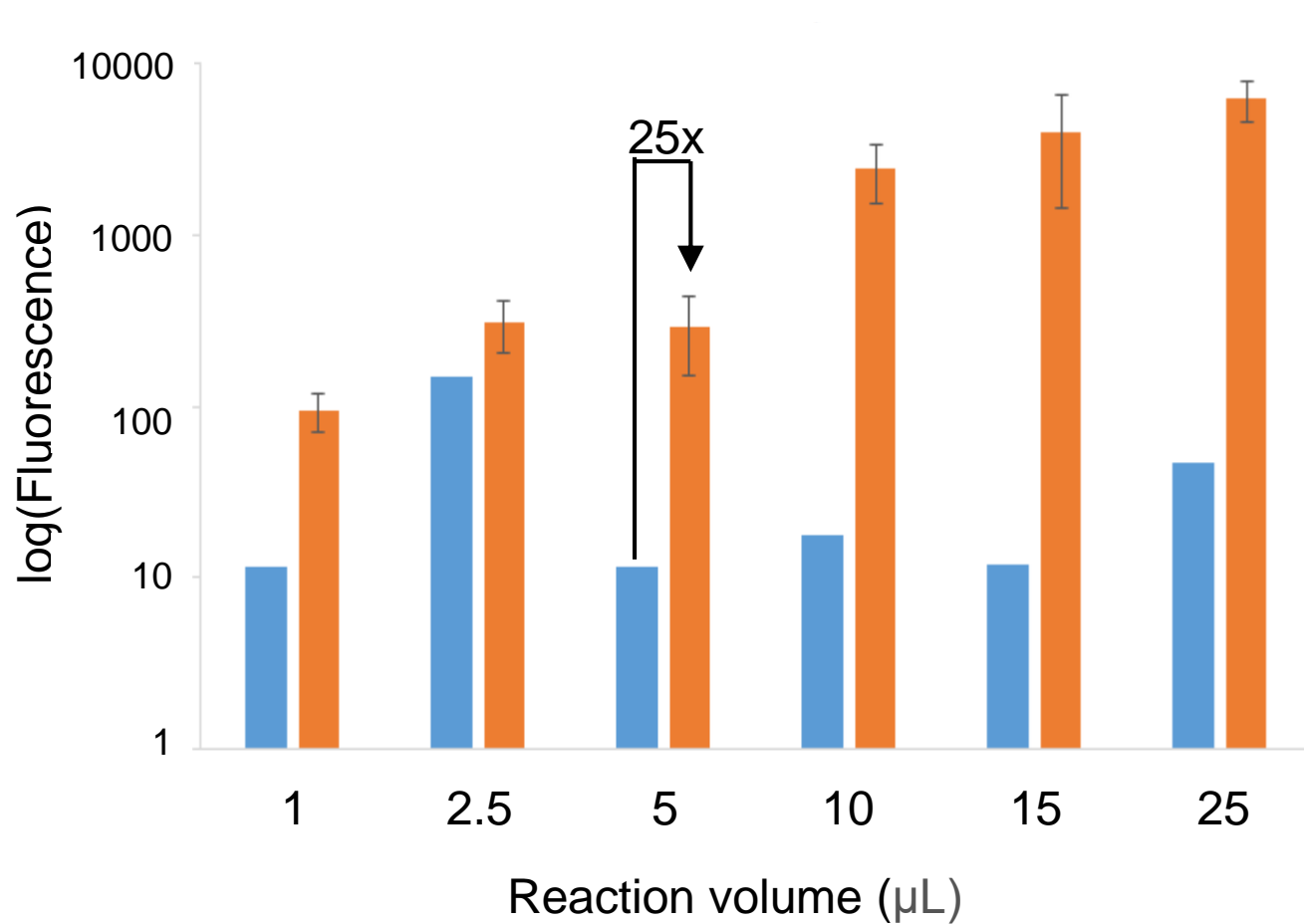


Pardee, Green, Ferrante, Cameron, DaleyKeyser, Yin, Collins. *Cell*.2014.

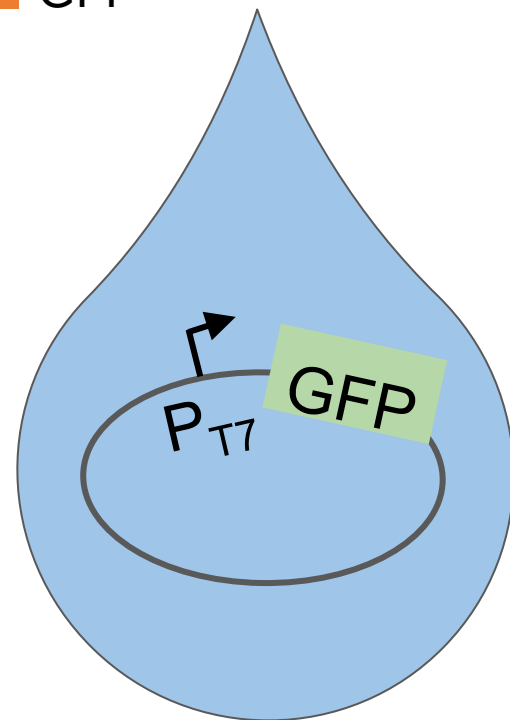
Why?

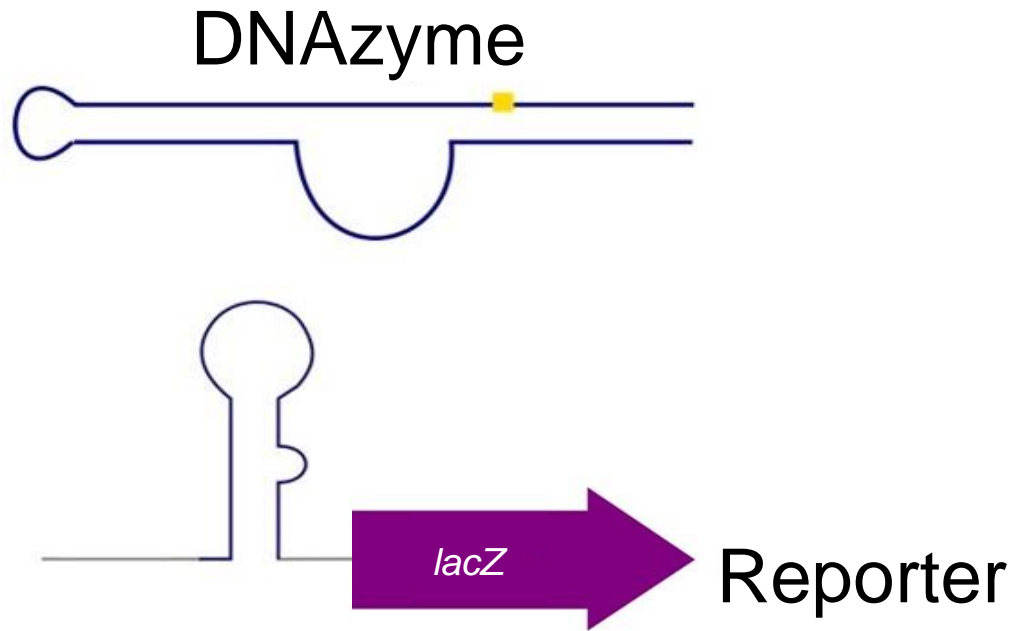


Reaction Volume Minimization

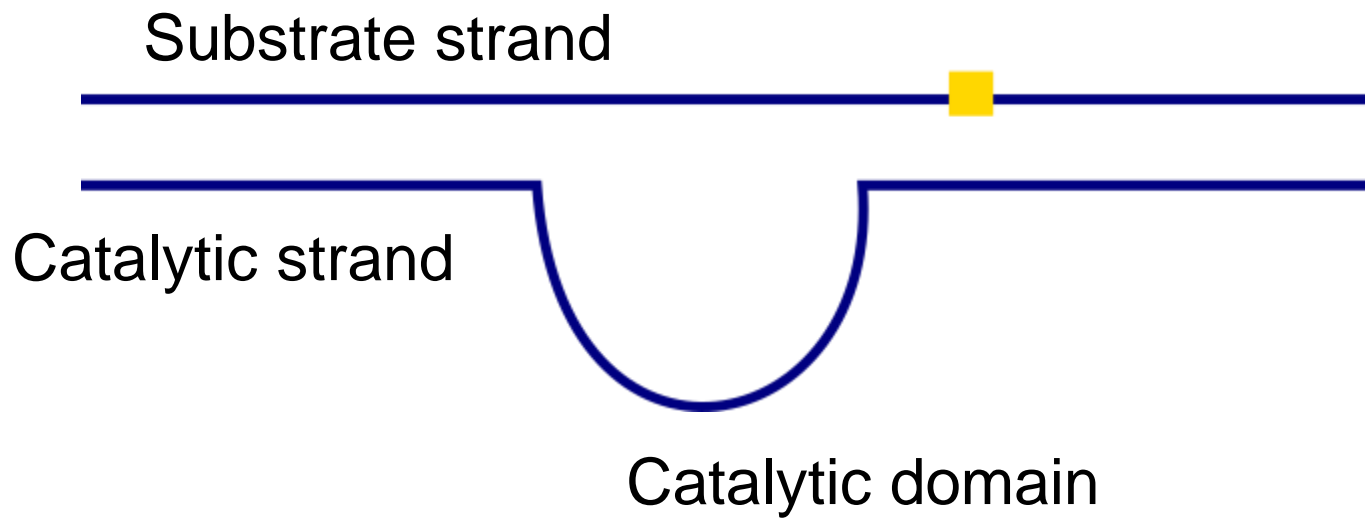


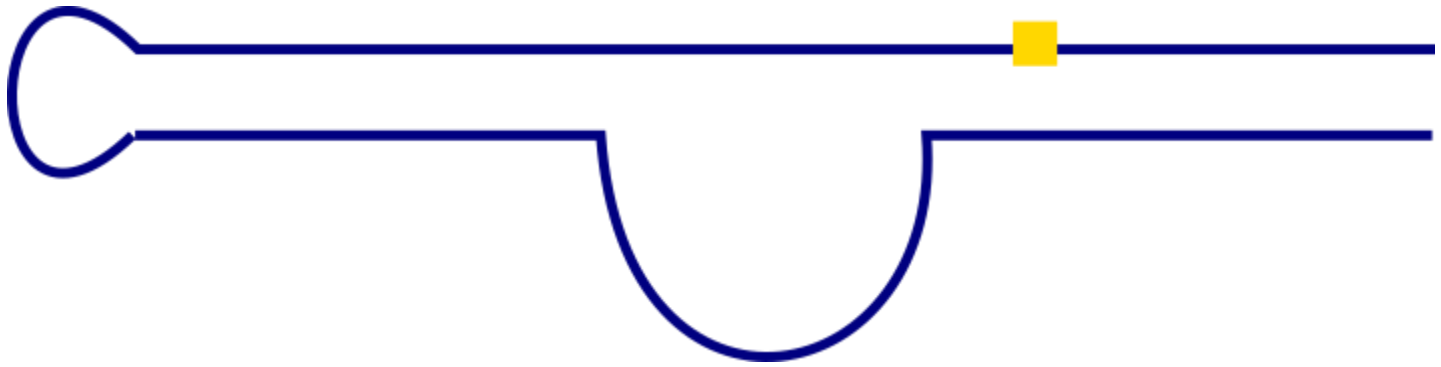
■ No DNA
■ GFP



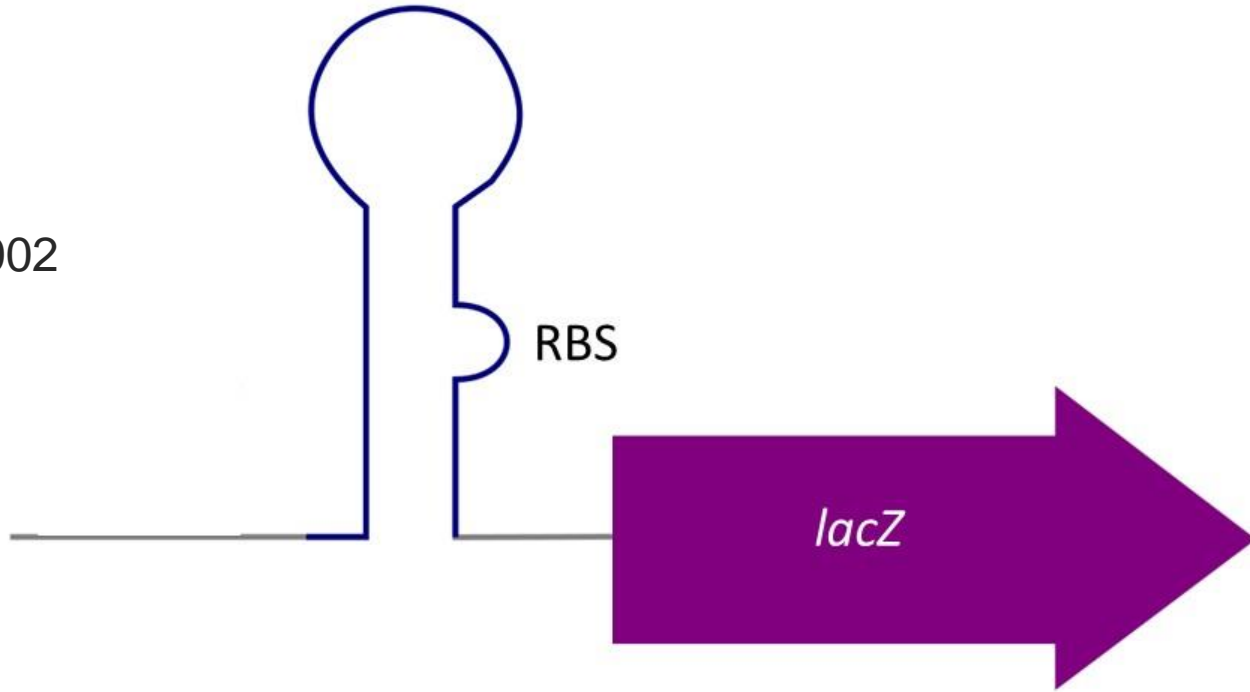


Toehold Switch





BBa_K2084002



Pardee, Green, Ferrante, Cameron, DaleyKeyser, Yin, Collins. *Cell*. 2014.

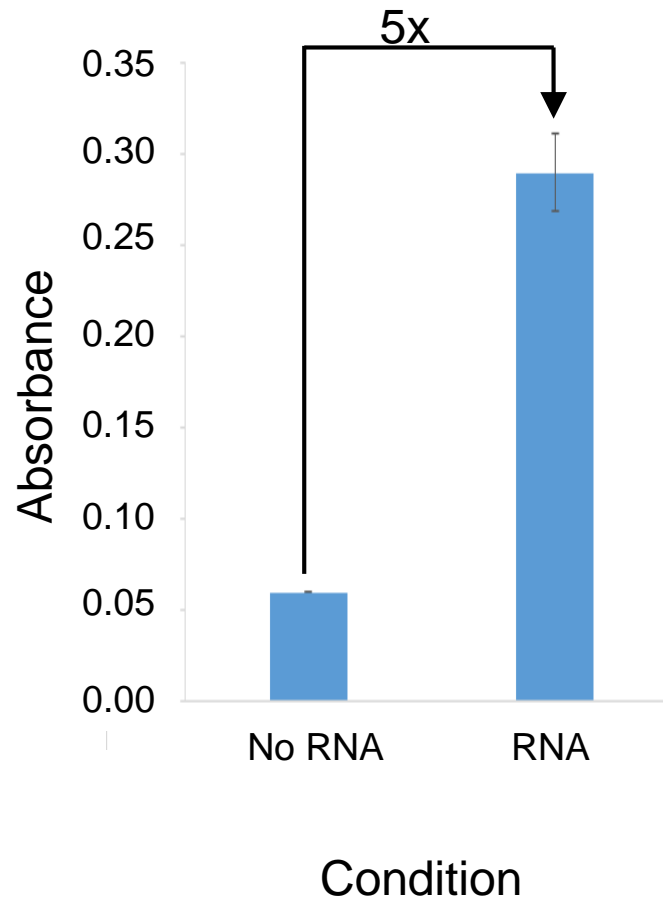
Reporter Substrate

CPRG (Chlorophenol Red- β -D-galactopyranoside)

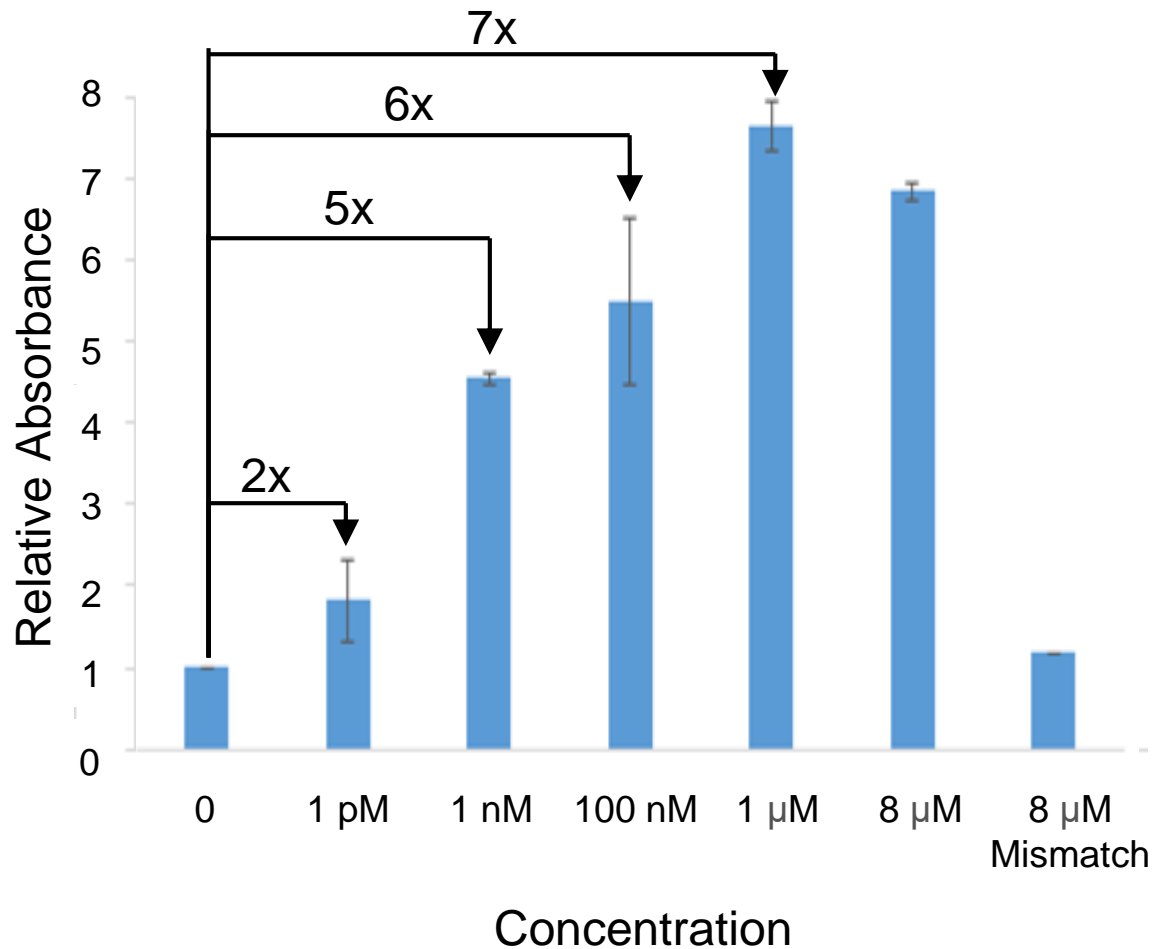
Undergoes color change when lacZ is expressed



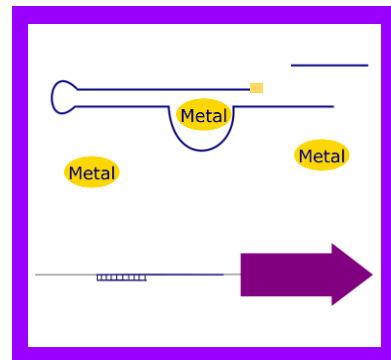
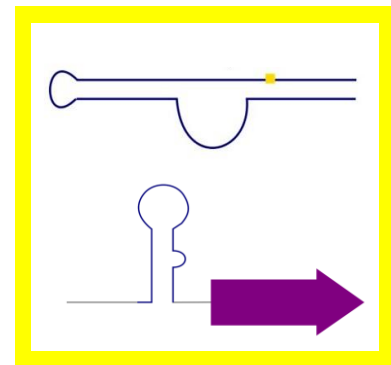
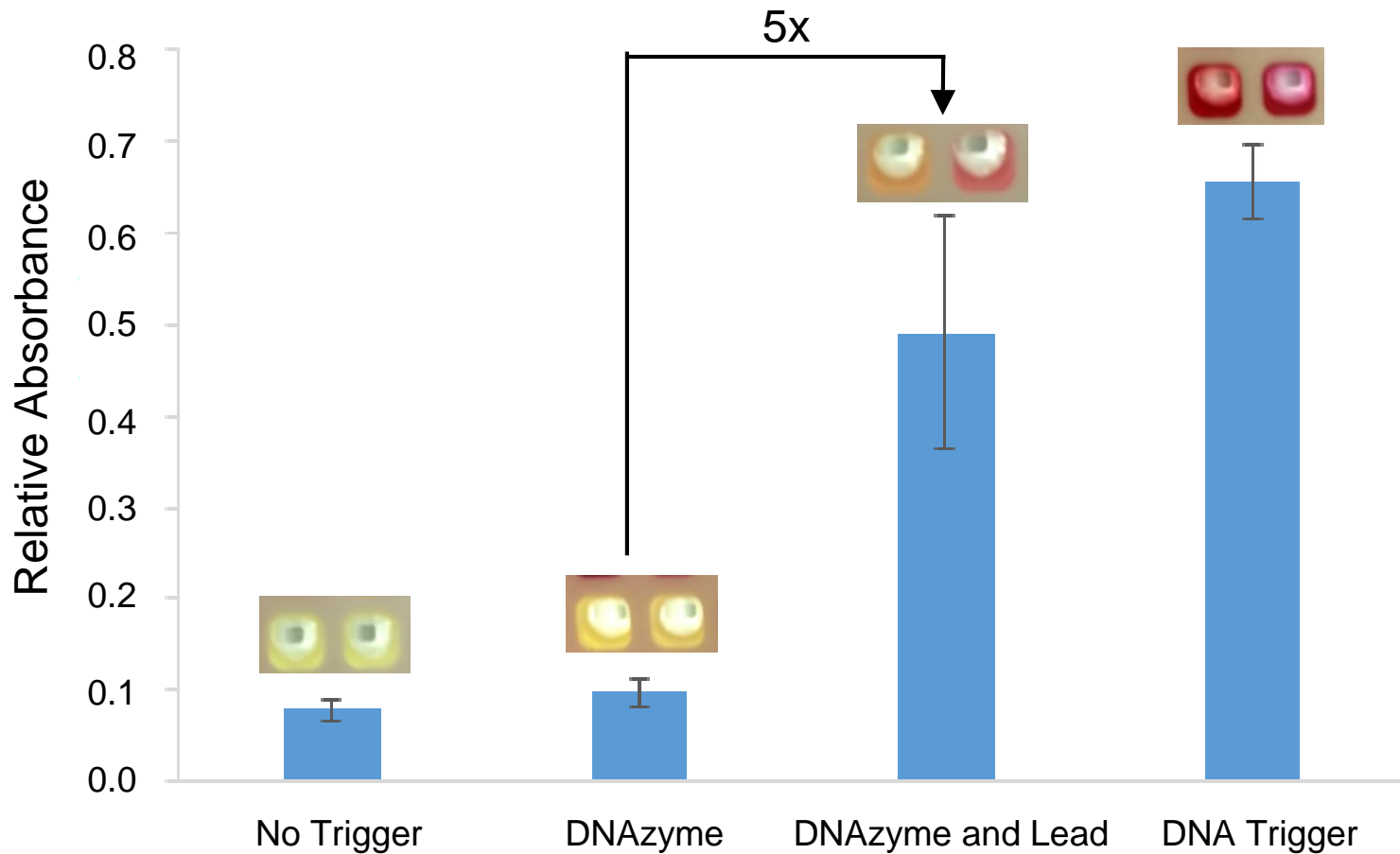
Activation with RNA



Activation with DNA

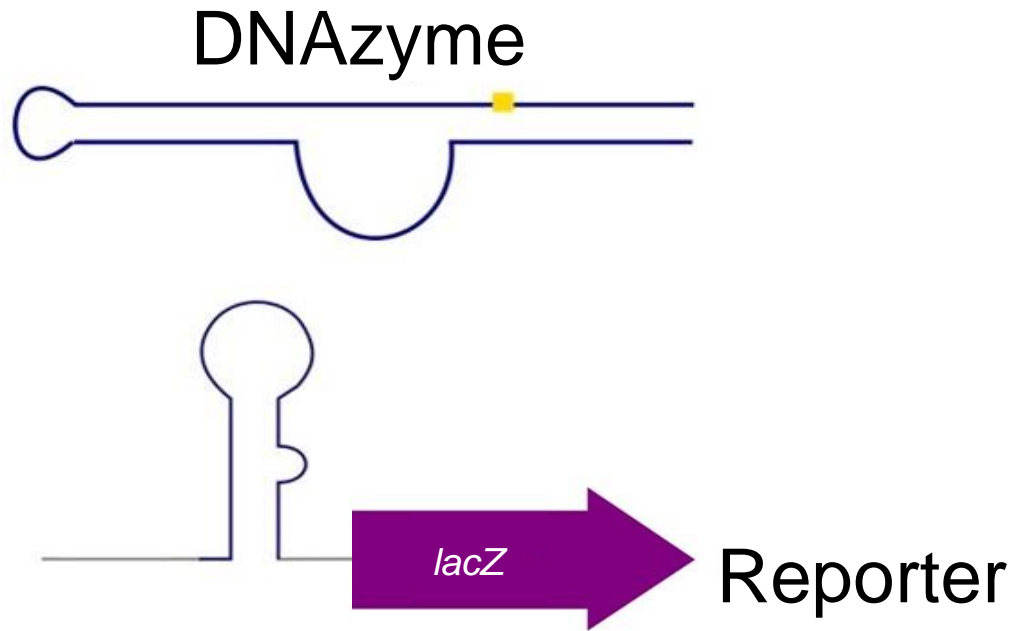


lacZ Expression with 2 μM Lead



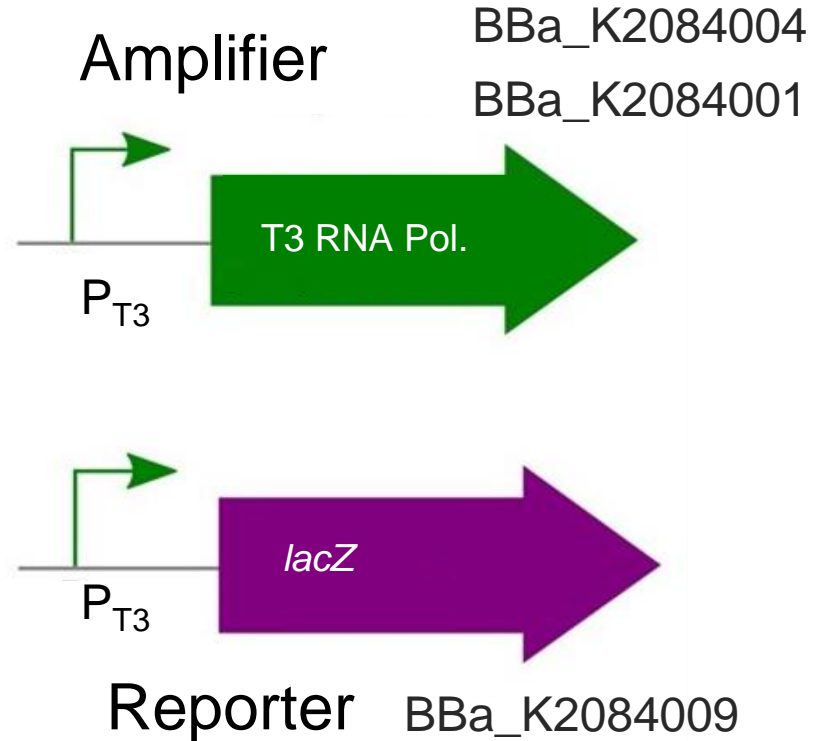
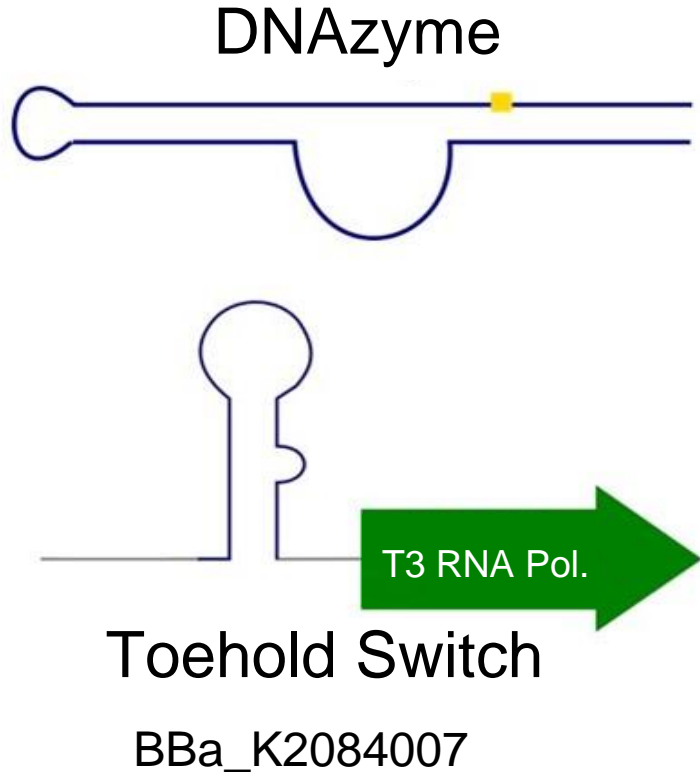
Comparison of Lead Concentrations

| Source | Concentration (ppb) | Concentration (nM) |
|------------------|---------------------|--------------------|
| EPA MCL | 15 | 72.4 |
| Hot Metal Switch | 429 | 2,000 |
| Flint, MI | 13,200 | 63,712 |



Toehold Switch

Current Project: Forward Feedback Amplification



Flexibility

Thallium



Lead



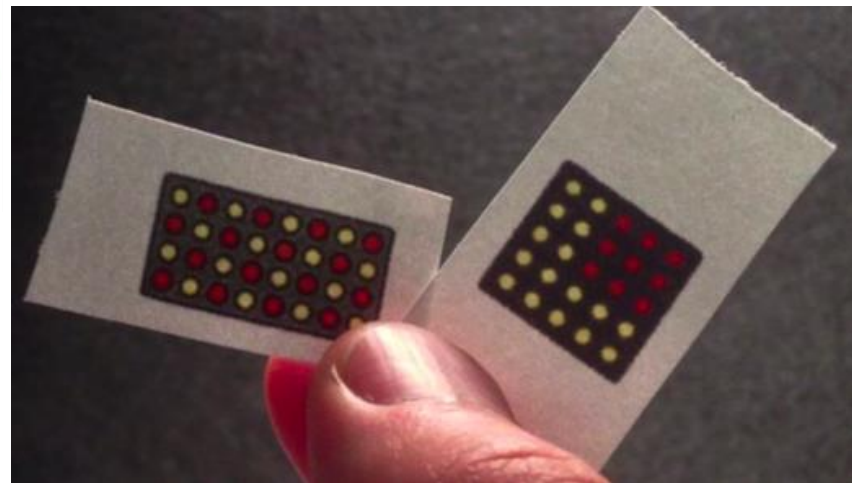
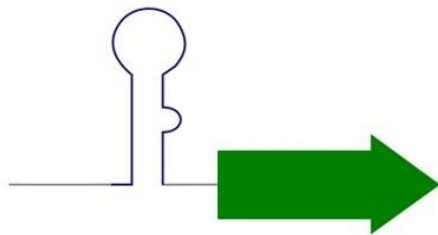
Mercury



Arsenic



Future work




Human Practices

**Synthetic biology:
how do we do it?**



Human Practices

Let's talk about DNA!



DNA is the instructions to make every living thing, including us! It's like a recipe book, which has the instructions to make a full meal.

DNA determines the way we look: eye color, height, hair color... We get it from our parents. That's why we look like them!

All humans in the world share 99.9% of their DNA. That means only 0.1% of DNA is responsible for our differences. That's crazy!

We also share 60% of our DNA with bananas and chickens!

Our DNA "recipe books" are split into individual recipes called genes.

Each gene makes one protein, the way each recipe makes one course. Proteins are what we actually see when we talk about eye color.

In synthetic biology, we rearrange recipes to make new recipe books for new meals. We combine genes in new ways to solve problems.


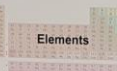

By putting jellyfish DNA in bacteria, we can make bacteria that glow in the dark, just like jellyfish!

See your own DNA!

Step 1: Lick your cheeks and spit into a cup.
Step 2: Add dish soap.
Step 3: Add salt and mix well.
Step 4: Add isopropyl alcohol and mix well.
Step 5: Pick up your DNA!

HOT METAL SWITCH
a metal detection system

Lead and thallium

Lead:  Elements:  Thallium: 

Uses

plates, batteries, water pipes, pesticides, food preservatives, makeup, and paint

Toxicity

throwing up, bad memory, painful muscles, hearing loss, slower learning

Water Contamination

from not throwing out metals properly
gets into drinking water

Our project: a lead and thallium sensor

Cell-free extract
liquid insides of a cell makes protein from DNA easy to work with

Sensor

DNAzyme cuts the top piece of DNA when there's lead or thallium. The switch turned on by the liquid from your test.

What is synthetic biology?

It's a new type of science about building new things from parts we find in living things.

Every living thing is made from many parts, the way this helicopter is made from many Lego bricks.

Synthetic biology parts are genes!

Synthetic biology: Combine genes in new way to build new machines that solve problems.

What is iGEM?

iGEM is a contest all about synthetic biology!

Teams from all over the world solve problems including:

- global warming
- chewing gum stuck to the sidewalk
- "Giant Jamboree" competition in Boston, where we share our work and learn from each other!

Logos: iGEM, University of Kentucky, IDT

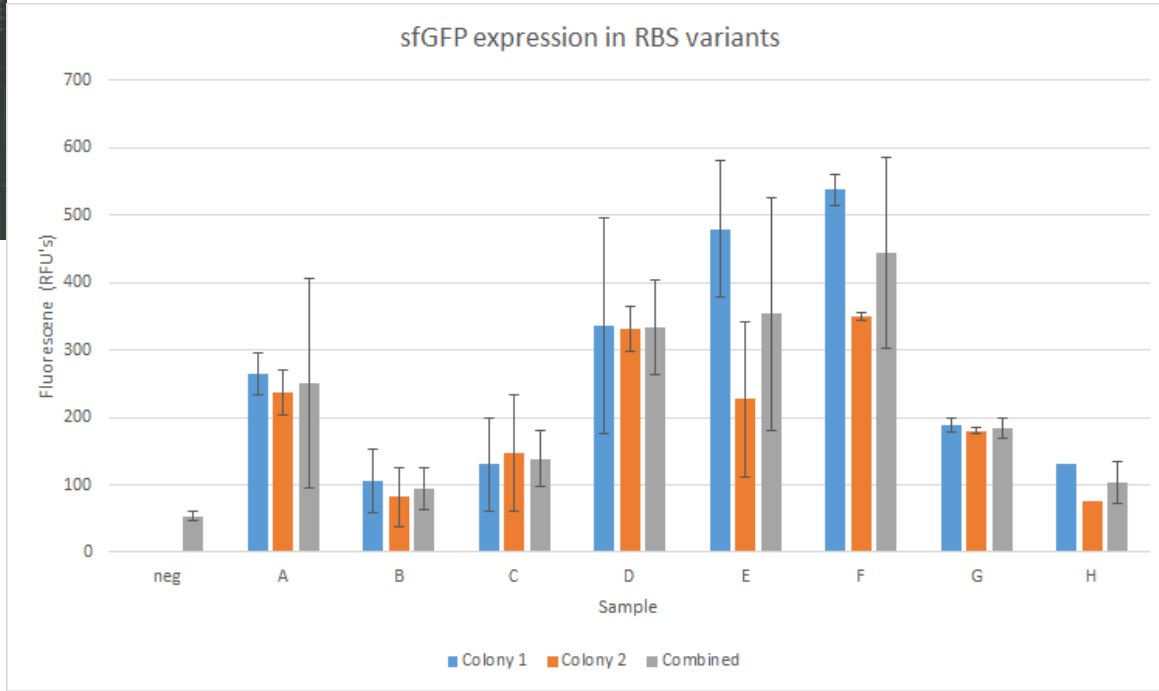
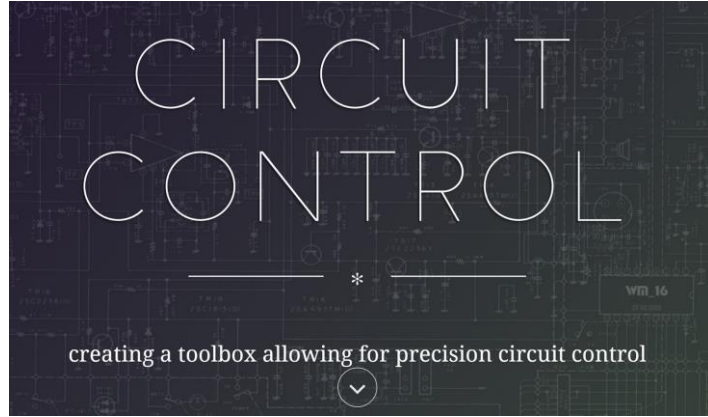


Human Practices



Lead
Pitt iGEM 2016

Collaborations



Collaborations

UGA iGEM

Athens, GA



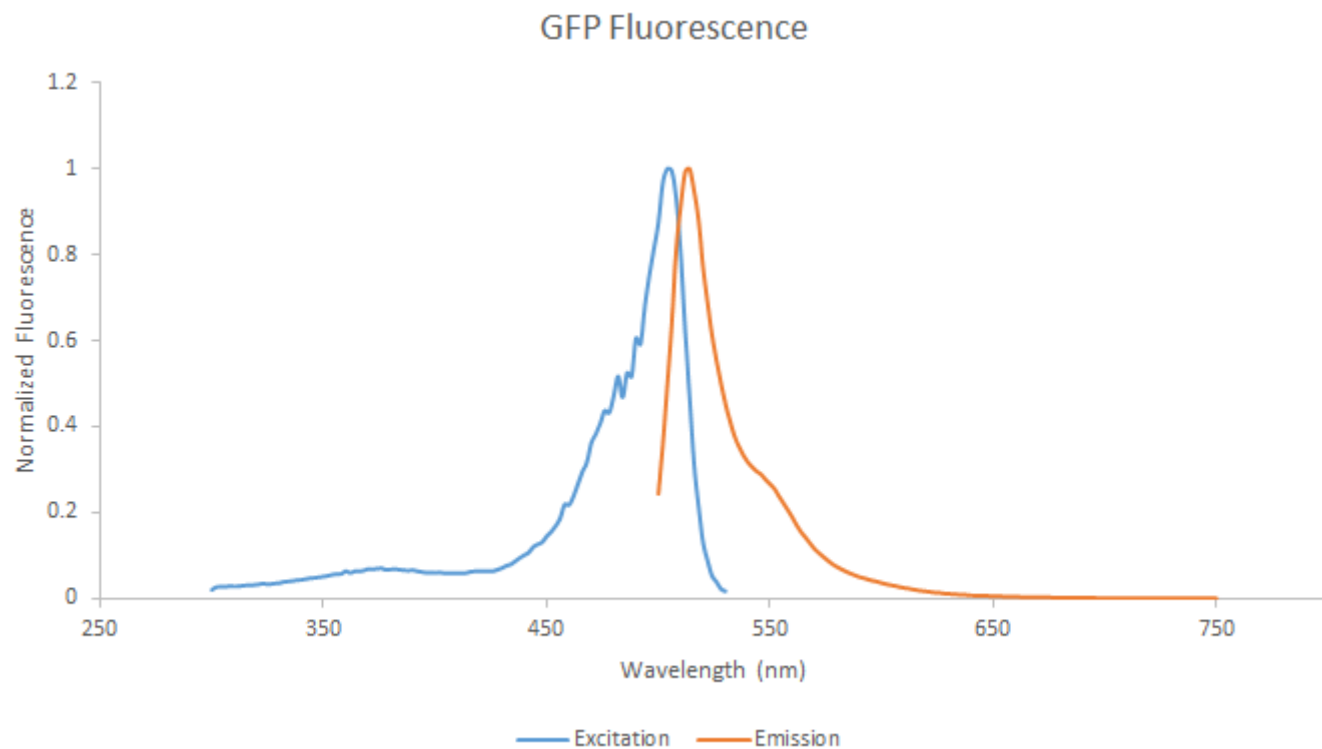
Sample

■ Colony 1 ■ Colony 2 ■ Combined

Collaborations



Collaborations



Conclusion

- Modeled the consequences of lead exposure
- Demonstrated DNA trigger of toehold switch
- Developed promising circuit with regulatory RBS
- Taught community about synthetic biology

Thank You!

Team



Aife Ni Chochlain

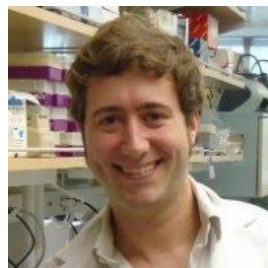
Sponsors



Advisors and Mentors



Dr. Alexander
Deiters



Dr. Jason
Lohmueller



Dr. Lisa
Antoszewski



Dr. Cheryl Telmer



Dr. Natasa
Miskov-Zivanov



Dr. Sanjeev
Shroff